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EXAMINER	
SELLERS, DANIEL R	
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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/766,599	Applicant(s) TAYLOR ET AL.	
	Examiner Daniel R. Sellers	Art Unit 2644	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *27 January 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities: The acronym NMR is not defined, however the office interprets the acronym to mean Nuclear Magnetic Resonance.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claim 1 recites the limitation "... and to generate the singular values...." in line 8 of the first paragraph. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1, 2, and 4-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over the IEEE Nuclear Science Symposium and Medical Imaging Conference paper titled “Application of DSP Techniques to Nuclear Magnetic Resonance Spectroscopy”

by Worley et al., Broomhead et al., U.S. Patent 5,453,940, and Izatt et al., U.S. Patent 6,002,480.

6. Regarding claim 1, Worley et al. teaches

An apparatus for performing spectral analysis, the apparatus comprising:
a. a data acquisition system configured to measure a signal emitted from a sample in response to excitation energy applied thereto (col. 1, lines 1-5 and col. 2, lines 11-13), *and to average the measured signal over a plurality of measurements to generate an averaged signal* (col. 3, lines 3-4),

b. a data processing system including:
a noise-reduction pre-processor configured to create a vector space from said averaged signal (col. 2, lines 11-13), *and to generate the singular values and corresponding eigenvectors of a correlation matrix constructed within said vector space* (col. 3, lines 18-19), *said vector space containing a noisefree signal subspace and a noise subspace, said singular values including noisefree singular values associated with said noisefree signal subspace, and noise singular values associated with said noise subspace* (col. 3, lines 29-33); *and*

Worley et al. does not teach a control system, however Worley et al. does teach all the other limitations. Broomhead et al. teaches a processing system that performs singular value decomposition of time series signals from non-linear systems.

c. a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value (col. 12, lines 36-50), *so as to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent further measurements from being made by the data acquisition system if the appearance and stability of said gap can be established.*

It would have been obvious to combine the teachings of Broomhead et al. with Worley et al. for the purpose of reducing the number of samples taken (Worley, Col. 3, line 3-5). Broomhead et al. does not teach a control system that requests additional measurements. Izatt et al. teaches a technique for depth-resolved coherent backscatter spectroscopy. Izatt et al.'s system uses Fourier domain techniques throughout, however Izatt et al. teaches a control system that requests or prevents the data acquisition system to perform additional measurements (col. 18, lines 9-14). It would

have been obvious to combine the teachings of Izatt et al. with the Worley, Broomhead combination for the purpose of reducing the time to acquire the samples. These systems when combined would reduce noise and make more accurate diagnosis possible (Worley et al., col. 1, lines 26-29, 35-37, and 41-43).

7. Regarding claim 2, with respect to claim 1, the further limitation,

... said spectral analysis comprises an NMR spectral analysis, said excitation energy comprises RF excitation pulses, and said measured signal comprises an NMR transient.

See claim 1 and Worley et al., column 1, lines 1-6. Worley et al. teaches a system that performs singular value decomposition in NMR spectral analysis.

8. Regarding claim 4, with respect to claim 1, the further limitation, see Worley et al.,

... said noise-reduction preprocessor comprises:

a. a matrix generator configured to form a vector space from the averaged signal (col. 3, lines 3-4) *and constructing a correlation matrix within the vector space* (col. 3, lines 18-19), *the vector space containing a noisefree signal subspace and a noise subspace;* (col. 3, lines 29-31).

b. a matrix diagonalizer configured to diagonalize the correlation matrix to obtain its singular values and the corresponding eigenvectors, the singular values including noisefree singular values associated with the noisefree signal subspace, and noise singular values associated with the noise subspace, and

With regard to the preceding limitation that the correlation matrix is diagonalized, it is a well-known step in the art of singular value decomposition, and as such is inherent. Worley et al. combined with Broomhead et al. and Izatt et al. teach the features in the first claim and Worley et al. teach a system that generates a vector space from an

averaged signal as discussed previously. Note that Broomhead et al. teach projection of signals onto the noisefree subspace.

c. a signal projector configured to project the averaged signal onto the noisefree subspace to generate a noise-reduced signal. (Col. 16, lines 19-22).

9. Regarding claim 5, with respect to claim 4, the further limitation, see Broomhead et al.,

... said data processing system further comprises a spectral estimator for generating a spectrum by converting said noise-reduced signal into a frequency domain. (fig 1, units 28 and 29, and fig 4(a), units f1-f28).

Worley et al. further teaches a system that converts the eigenvectors into a spectrum. Worley et al. uses the Multiple Signal Classification (MUSIC) algorithm, which does not use the noise-reduced signal. Note in Broomhead et al. that only the eigenvalues with acceptable noise are retained (col. 12, lines 52-57). Broomhead et al. further teaches the difference between the noise and noisefree eigenvalues with respect to figure 4(a) (col. 12, lines 36-50). Worley et al. discusses using the MUSIC or the Minimum Norm methods for spectral estimation (col. 3, lines 46-48), and it would have been obvious to one of ordinary skill in the art to substitute a different eigenvalue based spectral method, such as that of Broomhead et al., for the purpose of noise reduction.

10. Regarding claim 6, with respect to claim 1, the further limitation

See Worley et al.

... said data acquisition system is configured to sample each measured signal with a sampling period τ, and to average the corresponding sample points over said plurality of measurements (col. 3, lines 3-4), *so as to store said averaged signal as a discretized set of N data points c_n (n = 0, . . . , N-1).*

Worley et al. does not teach a system with a sampling period or a step of discretizing the input. Since Worley et al. uses DSP techniques, sampling with an appropriate frequency (at least twice the highest signal frequency) and digitizing the samples would have been obvious in order to perform DSP. Note that Broomhead et al. uses a sampling period τ, and Broomhead uses an Analog-to-Digital converter (ADC) (col. 4, lines 25-34).

11. Regarding claim 7, with respect to claim 6, the further limitation

... said data processing system is configured to store each data point c_n as a noisefree component x_n ($n = 0, \ldots, N-1$) and a noise component ε_n ($n = 0, \ldots, N-1$), and to store each noisefree component x_n as a finite sum of damped complex harmonics weighted by respective coefficients.

Worley et al. teaches a system that separates the signal into two subspaces by means of singular value decomposition (col. 3, lines 29-33). It would have been obvious that the signal when separated into its components would have been stored as the noisefree component and the noise component. Worley et al. does not teach a system that stores damped complex harmonics, however Worley et al. teaches that prior art used the discrete Fourier transform to create spectral information from NMR transients. It would have been obvious to one of ordinary skill in the art to use these teachings to create a device that stores the noisefree components as a finite sum of damped complex harmonics weighted by coefficients, in order to save computational time by converting to the frequency domain only once.

12. Regarding claim 8, with respect to claim 7, the further limitation,

... said sum is over a number K of said damped complex harmonics, so that each noisefree component x_n can be stored as:

$x_n = \Sigma\, d_k \exp(-iw_k \tau n)$

where d_k represents the weighting coefficient of the k-th damped complex harmonics, and w_k represents the complex frequency of the k-th damped complex harmonics.

See the rejection of claim 7, prior art teaches the use of Fourier techniques in spectral analysis. It would have been obvious to require the storage of coefficients corresponding to complex frequencies, as this is a well known method in the art.

13. Claims 9-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Worley et al., Broomhead et al., and Izatt et al. as applied to claims 1, 2, and 4-8 above, and further in view of Trickett, U.S. Application 10/660,713.

14. Regarding claims 9 and 10, with respect to claims 1 and 9 respectively, the further limitation of claim 9, see Trickett,

... said data acquisition system further comprises a windowing subsystem configured to apply a windowing filter to a Fourier transform of said averaged signal, so as to generate one or more decimated signals having a limited bandwidth. (fig. 5, unit 530)

and the further limitation of claim 10, see Trickett

... said data processing system is configured to store the inverse Fourier transform (fig. 5, unit 570) *of each decimated signal as a set of N_d decimated data points c_n^d ($n = 0, \ldots, N_d-1$), and wherein said set of decimated data points have a signal length N_d that is substantially less than N and a sampling period T_d that is substantially greater than τ.*

The application of Trickett teaches a method of noise reduction using matrix rank reduction. Trickett does not teach a system that uses averaged signals, however Worley et al. specifically teaches that averaged NMR transients are used as an input to

the system. It is inherent that the decimated data points have a smaller signal length and a sampling period greater than the input sampling frequency. It would have been obvious to one of ordinary skill in the art to combine these teachings, in order to reduce the amount of time involved in processing the data (Trickett, paragraph 17, lines 3-6).

15. Regarding claim 11, with respect to claim 10, the further limitation,

... said vector space created by said noise-reduction pre-processor comprises an M-dimensional vector space defined by a number N_d - M + 1 of linearly independent M-dimensional vectors, and wherein said data processing system is configured to store said M-dimensional vectors in a form given by:

$c_n^d = (c_n^d, c_{n+1}^d, \ldots, c_{n+M-1}^d)$,

where c_n^d represent said decimated data points.

Worley et al. teaches a system that creates an M-dimensional vector space from NMR transients. It is inherent that the system stores the M-dimensional vectors. Trickett teaches the method of decimating the data. It would have been obvious to one of ordinary skill in the art to combine these teachings as stated previously, in order to store data more efficiently.

16. Regarding claim 12, with respect to claim 11, the further limitation

... said correlation matrix constructed by said matrix generator is Hermitian and covariant, and has a dimension MxM, and wherein said correlation matrix is formed from said M-dimensional vectors and in accordance with a formula given by:

$R_{ij} = 1 / (N_d - M + 1)\ \Sigma\, c_{n+i-1}\, c^*_{n+j-1}$

See Worley et al. column 3, lines 18-19. Worley et al. teaches a system that uses an autocorrelation function. It is well known in the art that in certain cases an

autocorrelation matrix is both Hermitian and covariant, specifically in the case of real valued stationary random sequences with zero mean.

17. Regarding claim 13, with respect to claim 11,

... said projection of said averaged signal by said signal projector is based on a projection formula given by:

$c_n^{nr} = \Sigma_{k=1...K} (u^*_k, c_n)u_k$

where u_k represent said eigenvectors corresponding to said singular values.

Broomhead et al. teaches a system analyzer that uses singular value decomposition techniques. The system as taught by Broomhead et al., includes a method of projecting a signal onto eigenvectors (col. 16, lines 19-22). It would have been obvious to one of ordinary skill in the art to combine the further teachings of Broomhead et al. with the Worley et al., Broomhead et al., Izatt et al., and Trickett combination, for the purpose of reducing noise in the system.

18. Claims 3, and 14-24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Worley et al., Broomhead et al., and Izatt et al. as applied to claim 1 above, and further in view of Okazaki, U.S. Patent 5,148,522.

19. Regarding claim 3, with respect to claim 1, the further limitation

See Broomhead et al.

... said control system comprises:

a. a graphics system adapted to generate a plot of said singular values, (fig. 4a and 5a)

b. a pattern recognition system adapted to identify a gap in said plot between said noisefree singular value and said adjacent noise singular value, and to verify the stability of said gap; and

c. a command signal generator, responsive to said pattern recognition system, configured to generate an output signal requesting for more measurements from said data acquisition system, in the absence of an definable gap, and to generate an output signal requesting that further measurements be discontinued, if the appearance and the stability of said gap has been established by said pattern recognition system.

Broomhead et al. teaches a processing system that performs singular value decomposition of time series signals from non-linear systems. The system does not perform pattern recognition, however the teachings point out the specific characteristics of the singular value plot (col. 12, lines 36-57). The system also does not request or discontinue further measurements. Izatt et al. teaches a technique for depth-resolved coherent backscatter spectroscopy. The technique involves requesting more measurements when there is a lack of sufficient data to create meaningful data (fig. 4a and col. 18, lines 9-14). Izatt et al. does not teach a pattern recognition system. Okazaki teaches a pattern recognition system for identifying and retrieving two-dimensional information (col. 1, lines 18-31). Okazaki does not teach a spectroscopic method. However, Okazaki teaches that the system can be configured to recognize retrieval conditions (col. 2, lines 7-18). It would have been obvious to one of ordinary skill in the art to combine these teachings of Worley et al., Broomhead et al., Izatt et al., and Okazaki. These systems when combined would shorten the length of time needed to acquire signals of interest.

20. Regarding independent claims 14-19, 21, and 24, see the rejections of claims 1-5. It would have been obvious to one of ordinary skill in the art to combine the

teachings of Worley et al., Broomhead et al., Izatt et al., and Okazaki in order to reduce noise and shorten processing time.

21. Regarding claim 20, with respect to claim 19, the further limitation,

... said spectrum comprises an NMR spectrum, and said data measurements comprise NMR transient acquisitions.

Worley et al. teaches a system that comprises an NMR spectrum and data measurements that comprise of NMR transient acquisitions (col. 1, lines 1-6). It would have been obvious to one of ordinary skill in the art to combine the teachings of Worley et al., Broomhead et al., Izatt et al., and Okazaki as explained previously.

22. Regarding claim 22, the further limitation of claim 21,

... steps b, c, and d are implemented by an operator of a control system.

Broomhead et al. teaches a processing system that performs singular value decomposition of time series signals from non-linear systems. They plot the singular values and point out specific characteristics present in the singular plot (fig. 4a, item 80). It is inherent that those specifics where chosen by the authors. It would have been obvious to one of ordinary skill in the art to combine the teachings of Worley et al., Broomhead et al., Izatt et al., and Okazaki, so as to obtain a device that is controlled by an operator.

23. Regarding claim 23, the further limitation of claim 21,

... steps b, c, and d are implemented by a processor upon execution by said processor of computer-usable instructions stored on a computer-usable medium.

Okazaki teaches a pattern recognition system to select user defined characteristics of a 2-D plot, and Izatt et al. teaches a control system that responds to requests for additional measurements. It would have been obvious to one of ordinary skill in the art to combine these teachings with Worley et al., and Broomhead et al. as previously stated.

Conclusion

24. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Hutson, U.S. Patent 5,490,516A, and IEEE Transactions on Signal Processing “An Eigenanalysis Interference Canceler” by Haimovich et al.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel R. Sellers whose telephone number is 703-605-4300. The examiner can normally be reached on Monday to Friday between 9am and 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Forester W. Isen can be reached on 703-305-4386. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DRS

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